IS 11538 (1986): Code of practice for design and installation of farm drainage pumping plant [FAD 17: Farm Irrigation and Drainage Systems]

BLANK PAGE

IS : 11538 - 1986

(Reaffirmed 2000)

Indian Standard

CODE OF PRACTICE FOR DESIGN AND INSTALLATION OF FARM DRAINAGE PUMPING PLANTS

UDC 631·624·005 : 006·76

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4 *June* 1986

Indian Standard

CODE OF PRACTICE FOR DESIGN AND INSTALLATION OF FARM DRAINAGE PUMPING PLANTS

Composition of the Farm Drainage Sectional Committee, AFDC 47

Chairman	*Representing*
Dr A. M. Michael	Indian Agricultural Research Institute (ICAR), New Delhi
Members	
Dr A. K. Bhattacharya (*Alternate* to Dr A. M. Michael)	
Dr M. C. Agarwal	Haryana Agricultural University, Hissar
Dr Bhupal Singh	Tocklai Experimental Station, Jorhat
Dr H. S. Chauhan	G. B. Pant University of Agricultural and Technology, Pantnagar
Dr Sewa Ram (*Alternate*)	
Chief Engineer	PWD Irrigation (North), Government of Karnataka, Belgaum
Superintending Engineer (Designs) (*Alternate*)	
Director	Irrigation Research and Development, Pune
Executive Engineer (*Alternate*)	
Director (FCM)	Central Water Commission, New Delhi
Shri V. S. Hegde	Hulgul Group Cooperative Society, Sirsi
Shri N. G. Joshi	Indian Hume Pipe Co Ltd, Bombay
Shri S. D. Khepar	Punjab Agricultural University, Ludhiana
Dr Sita Ram Singh (*Alternate*)	
Shri V. Pattabhi	Hyderabad Industries Ltd, Hyderabad
Shri A. K. Gupta (*Alternate*)	
Dr H. Purnapragnachar	University of Agricultural Sciences, Bangalore
Dr R. K. Rai	Rajendra Agricultural University, Patna
Dr T. K. Sarkar	Damodar Valley Corporation, Calcutta
Shri G. K. Srinivasan	Wavin India Limited, Madras
Shri K. R. Rangarajan (*Alternate*)	
Shri V. Vasudevan	Khadi and Village Industries Commission, Bombay
Shri B. P. Srivastava (*Alternate*)	
Shri T. Purnanandam, Director (Agri & Food)	Director General, ISI (*Ex-officio Member*)

Secretary

Shri R. N. Sharma
Joint Director (Agri & Food), ISI

Indian Standard

CODE OF PRACTICE FOR DESIGN AND INSTALLATION OF FARM DRAINAGE PUMPING PLANTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 31 January 1986, after the draft finalized by the Farm Drainage Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 This standard is intended to provide principles and practices useful to engineers in the planning and design of pumping plants for drainage of farm land.

0.3 In preparation of this standard, assistance has been taken from ASAE EP 369-1974 'Design of agricultural drainage pumping plants,' issued by the American Society of Agricultural Engineers, USA.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the results of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the guidelines for design and installation of pumping plants for farm drainage purposes.

NOTE — This standard does not cover the pumping plant for deep well drainage.

2. CLASSIFICATION OF WATER STORAGE SYSTEM

2.1 Water storage system for pumping plants shall be classified as follows:

a) *Open Storage Tank* — For collecting and temporarily storing both surface and ground water.

b) *Sumps* — For storing ground water only.

*Rules for rounding off numerical values (*revised*).

NOTE — Under the monsoonic rainfall situation, surface drainage component would be much more than the subsurface one. On the other hand, during post monsoon period, pumping requirement would essentially consist of subsurface component and capacity of pumps would be much lower. A drainage pumping plant under such situtation would require design of two pumping plants; larger one to meet monsoon requirement and smaller one for post monsoon period.

3. PLANNING OF AREA TO BE PUMP DRAINED

3.1 The drainage system of the area served by the pumping plants should be planned to meet both drainage needs of the area as well as efficient operation of the pumps.

3.1.1 Runoff from high ground, when removable by gravity flow to a suitable outlet, should be excluded from the pumped area by diversion around the area or by channelling through the area.

3.1.2 Protection of pumped area against overflow or back water from the outlet should be provided by perimeter dikes designed against overtopping, wave action, erosion and instability of high water stages. Direct disposal of stored water by gravity in the storage reservoir could be made by the pipe outlets through the embankment. These outlets should be protected by gates to prevent backflow during the high exterior water stages and permit outflow during low water stages. This would reduce load on pumping system.

3.1.3 The drainage system of the pumped area should provide the following:

a) An optimum storage tank/sump water stage commensurate with the designed depth of water table.

b) In case of surface drainage system, use of undeveloped swamp or low land near or adjoining the pumping plant to supplement tank/sump water storage for reduction of the pumping rate.

c) Drainage channels discharging water to the water tank/sump should be suitably designed to avoid channel scour.

3.1.4 Pumping plant location should be at or near the point of lowest elevation of the pumped area and accessible to an adjacent outlet. Site adjustments should be made as necessary to provide foundations without excessive use of piling, freedom from flooding of operating equipment, ready access to fuel or power supply and protection from vandalism.

3.2 The outlet channel from the pumped area shall be adequate for handling the discharge. If it is to discharge in an irrigation canal system, the applicable statutory requirements should be followed.

4. PUMPING PLANT CAPACITY

4.1 The pumping rate and frequency should be determined from the drainage requirement and temporary storage.

4.1.1 The drainage requirement would vary with climate, topography, soils, land use, types of crops and cost effectiveness of the system. Such requirements may be expressed as a coefficient or quantity of water to be removed per unit of area per unit of time. Drainage coefficient should be computed on the basis of local data (*see also* 4 of IS : 10907-1984*).

4.1.2 Pumping plant capacity for surface and/or subsurface drainage should be based on surface and/or subsurface drainage designed coefficients respectively.

5. PUMP SELECTION AND INSTALLATION

5.1 The selection of the drainage pump would usually be based on designed discharge and total head as well as type of power available.

5.2 Pump performance varies with head, speed, discharge and power relationships. The effect of these factors on efficiency of the pumping operation may be obtained from pump manufacturer's performance curves or pump characteristics for each kind and size of pump made.

5.2.1 Cavitation is caused as a result of absolute pressure dropping below the vapour pressure of the liquid which passes through suction and impeller inlet. It results in pump vibration and noise, reduces pump discharge and efficiency and causes pump deterioration. Performance curves are useful for guidance in making proper selection and to ensure proper operation without cavitation. These curves would help to avoid the following at the time of pump selection:

a) Heads much higher than those at optimum efficiency.

b) Capacities much lower than capacity at peak efficiency.

c) Suction lifts abnormally higher, or net positive suction heads (NPSH) lower than the rated for the pump.

d) Speeds higher than those recommended for the pump.

5.3 Total head (H_t) is sum of static head (H), velocity head (H_v) and friction head (H_f) and is total energy that a pump should impart at designed discharge.

5.3.1 Static head or lift, is the vertical distance between the free water surface at the suction side of the pump and the free water surface at the discharge pipe side of the pump when discharge pipe is submerged, or at the centre of the discharge pipe when discharge pipe is not submerged. For the purpose of designing, H is to be considered from the lowest level on the suction side to the highest water level on the discharge pipe side.

*Code for design of farm drainage tile or pipe system.

5.3.2 Velocity head (H_V) in m, for various pump sizes and capacities can be calculated as follows:

$$H_V = \frac{V^2}{2g} = 0{\cdot}083 \frac{Q^2}{D^4}$$

where

V = column velocity at discharge end, m/s;

Q = pump capacity, m^3/s;

D = diameter, m; and

g = acceleration due to gravity.

5.3.3 When water or any other liquid moves through a pipe line, the latter offers some resistance to the flow. This resistànce depends on the diameter, length, type and condition of the pipe and its fittings and velocity of flow. The values of head loss due to friction in pipes may be obtained on the basis of IS : 2951 (Part 1)-1965*. Head loss due to friction for PVC pipes may be obtained from the supplier.

5.3.3.1 When calculating pipe losses allowances should be included for tees, bends, valves, and other fittings and obstructions in a particular pipe line. The values can be obtained from IS : 2951 (Part 2)-1965† and added to the value obtained for straight pipes (*see* **5.3.3**).

5.4 Size of pump (diameter of the discharge pipe at the pump outlet) can be calculated on the basis of the following formula:

$$D = 1{\cdot}13 \frac{(Q)^{\frac{1}{2}}}{(V)}$$

where

D = size of the pump, m;

Q = pump capacity, m^3/s; and

V = column velocity, m/s.

5.4.1 The column velocity of a pump may range between 2·0 to 3·7 m/s, however 3 m/s may be used as an initial estimate in developing the pumping plant design.

5.5 The discharge pipe should be of adequate capacity and water tight.

---

*Recommendation for estimation of flow of liquids in closed conduits: Part 1 Head loss in straight pipes due to frictional resistance.

†Recommendation for estimation of flow of liquids in closed conduits: Part 2 Head loss in valves and fittings.

5.5.1 The discharge pipe may be gradually enlarged away from the pump by several pipe sizes to decrease velocity head and thereby decrease the power cost.

NOTE — The friction losses in the discharge pipe can be reduced greatly by use of larger diameter pipe, usually 5 to 15 cm larger than the pump discharge flange. The transition can be made through a short expanding section of pipe at the pump flange, usually over a length of 60 cm (*see* Fig 1).

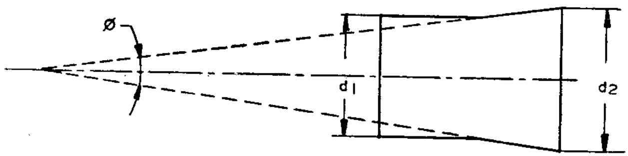

FIG. 1 DIAGRAM INDICATING USE OF LARGER PIPE TO REDUCE FRICTION LOSS

5.5.2 Submerged discharges are recommended to keep heads as low as possible. A non-return or flap valve should be used at the pipe end to prevent backflow through the pump. Erosion protection from discharging water should be considered when outletting into a earthen channel.

5.5.3 A siphon may be used whenever drainage water is pumped over a dike for both reduction in total head and reduction in power cost.

5.5.3.1 Priming head shall be greater than operating head. The pump should be able to deliver a full cross section of water over the crest at a velocity over 1·5 m/s. However, a limit on maximum lift of the siphon and maximum velocity of flow at the crest should be maintained to prevent reducing inside pressure at the crest to avoid cavitation. Discharge pipe should be sufficiently submerged to prevent air entrainment. The pipe section at the crest should have sufficient strength to resist external atmospheric pressure.

5.5.3.2 A siphon breaker shall be installed at the highest point in pipeline to prevent reverse flow during a power interruption (*see* Fig. 2). The siphon breaker would be actuated when power stops or flow reverses. The non-return flap valve at the end of the discharge pipe may serve in lieu of a siphon breaker for small pumping plants.

5.5.3.3 An air release valve is required to insure smooth priming of the siphon. This is preferably installed at the top of the bend outlet of the discharge pipe and near the water surface.

5.6 Typical drainage pump installations and head relationships that should be considered in their design is shown in Fig. 2. In installation, guidance may be taken from IS : 9694 (Part 2)-1980*.

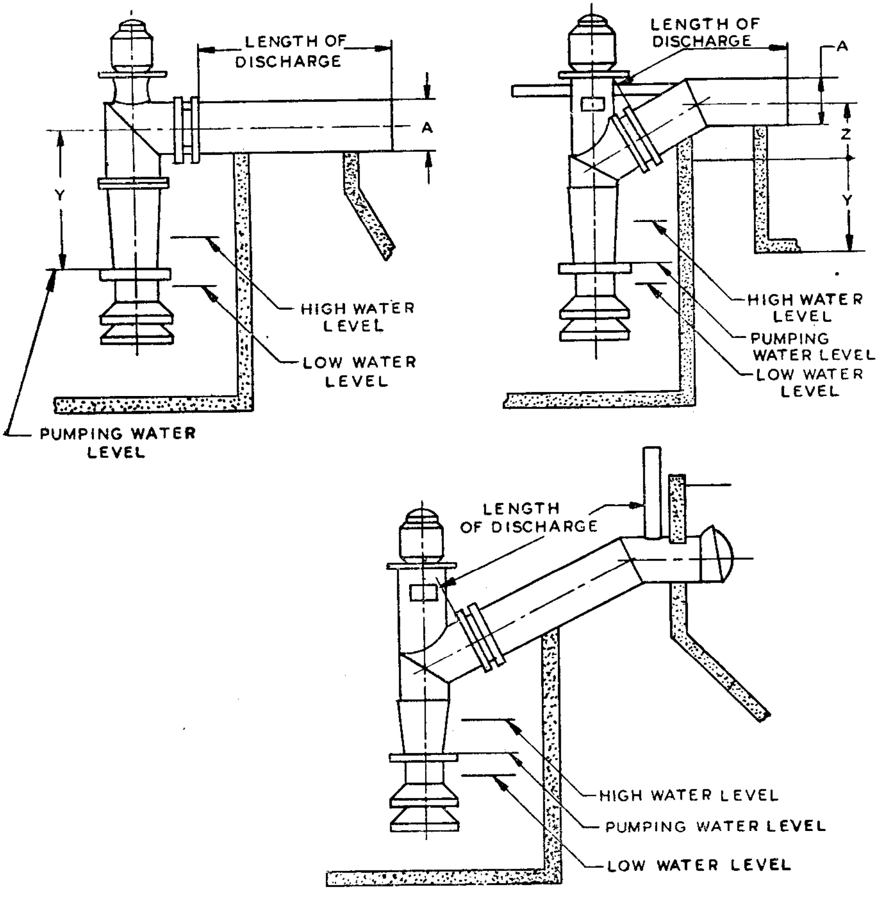

FIG. 2 TYPICAL DRAINAGE PUMP INSTALLATION — *Contd*

---

*Code of practice for selection, installation, operation and maintenances of horizontal centrifugal pumps for agricultural purposes: Part 2 Installation.

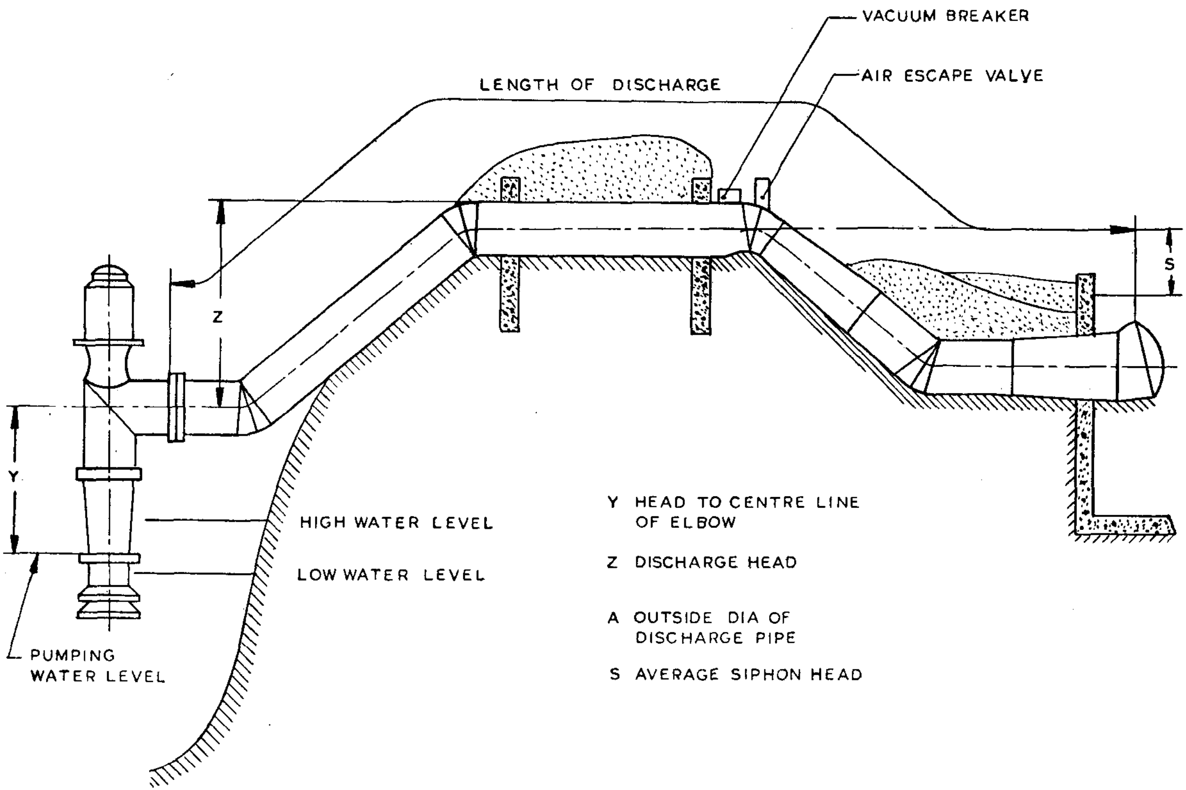

Fig. 2 Typical Drainage Pump Installations

6. STORAGE

6.1 The volume of drainage runoff to be stored in the tank/sump and auxiliary areas will vary from a maximum expected total runoff of the designed storm to a minimum set by the pumping rate that would prevent excessive numbers of pump starts and stops by the power source.

6.2 For manual operation of the pumps, pump starts may be limited to two per day for convenience of the operator. The volume of storage for two starts per day should be calculated on the basis of following formula:

$$S = 11\,235\,Q$$

where

S = volume of storage, m^3, and

Q = pump capacity, m^3/s.

6.3 For automatic operation of pumps, cycles of operation should be limited to about 10 per hour. This occurs when inflow is equal to one-half of the pump capacity. Minimum storage may be calculated as follows:

$$S = 90\,Q$$

where

S = volume of storage, m^3, and

Q = pump capacity, m^3/s.

7. TANK/SUMP DESIGN

7.1 The shape, size, and position of the storage tank/sump with respect to the pump affect the efficiency of the pumping operation.

7.2 Efficient pump operation requires special sump dimensions and pump clearance for smooth free flow of water in the suction intake pipe. Essential clearances are shown in Fig. 3. Sump water level should be maintained above a minimum submergance of the pump suction intake and is determined by the greater of the following independent conditions:

a) Water cover over the propeller should be sufficient to keep the pump self-priming.

b) Net positive suction head (NPSH) should be as determined by the pump manufacturer to overcome cavitation.

c) Submergence, as usually recommended in manufacturers' literature for vortex suppression, determined approximately from the following formula, is maintained:

$$K = \frac{2Q}{\pi d^2}$$

where

K = Minimum submergence, m;

Q = Pump capacity, m^3/s; and

d = Pump suction bell diameter, m.

d) Water storage capacity should be sufficient to prevent too frequent pump starts and stops.

7.2.1 Sump dimensions for automatic operation can be varied to fit field condition and be in line with economical installation. Generally the sump should not be deep but large and shallow. For efficient automatic operation, storage depth of sump of 0·7 to 1·0 m below the bottom of the pump is recommended. Greater sump storage depth usually add to both installation and operation costs of the pumping plant. In some soils, wide and frequent fluctuations in water depth cause serious bank sloughing and channel erosion.

7.2.2 In case of large circular sump, rotational effect can be minimized by placing the pump near the wall.

7.2.3 Floor of the approach channel and sump should be level for a distance of 5 times of diameters of the suction bell measured from the centreline of the pump. Approach velocity to the pump should be kept to 0·3 m/s unless the sump configuration has been checked for eddy currents by the manufacturer. Trash rack openings below minimum static water level should permit water passage at designed velocity.

7.2.4 Side wall clearance of pumps should not be less than $2\frac{1}{2}$ times the diameter of the suction bell.

7.2.5 Minimum clearance between adjacent pump centrelines should be the sum of the diameters of the suction bells.

7.2.6 Back wall clearance of pumps may be reduced to that necessary for maintaining the pumps.

7.2.7 Where ditch storage is provided, size of culvert inlet passing water to the sump should be sufficient to handle the maximum pump discharge at a velocity not exceeding 0·6 m/s.

7.2.8 Drain tile outlets discharging into a sump should be located as far from the pump as possible so as to minimize effect of turbulence and air entrainment.

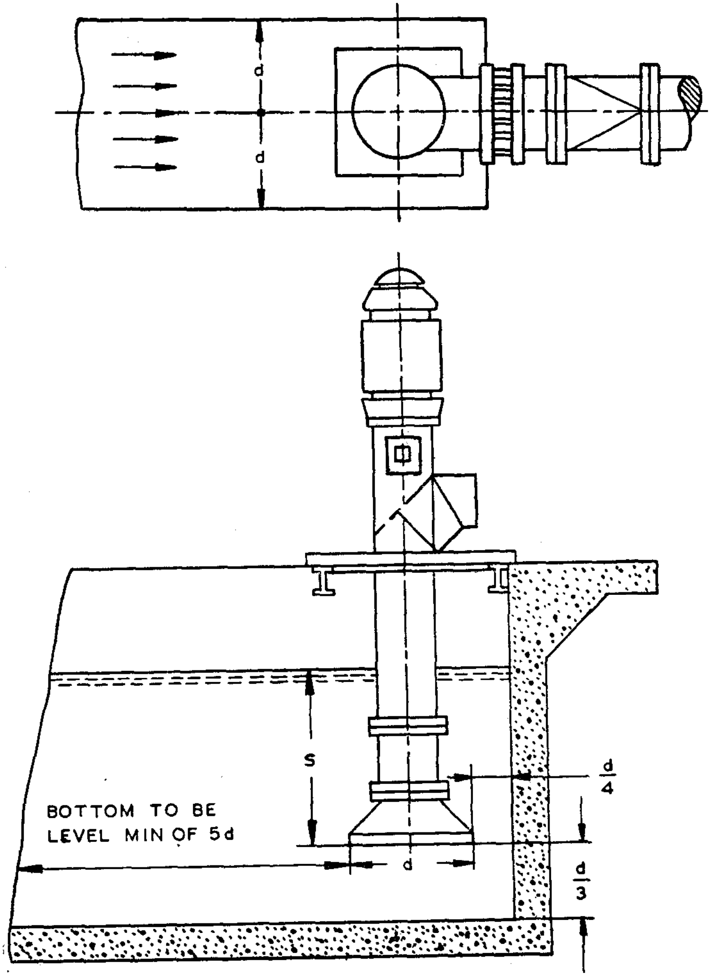

FIG. 3 RECOMMENDED SUMP CLEARANCES

8. POWER SOURCE

8.1 Driving units for pump may be electric motors, diesel, petrol or gas fueled engines. Electric motors provide an economical installation when an adequate and reliable source of electric power is available close to the site at reasonable cost. Internal combustion engines should be used when

the source of electric power is not reliable or is too costly. Use of alternate sources of energy like wind mills and solar energy should be considered wherever feasible.

8.2 Electric power is convenient for pump drainage operation and easily adapted to automatic operation. Motors and controls should conform to requirements of the relevant Indian Standards.

8.3 Diesel and petrol engines may be adapted for variation in speed over a broad range and are limited only by the range of critical speeds which produce dangerous torsional vibrations.

9. DRIVE HEADS

9.1 Drive heads are required to connect the power source to the pump. Loss of efficiency through these units range from none in direct connections to about 5 percent in gear connections, and up to 10 percent in multiple belt connections. Proper direction of pump rotation should be maintained in all drive applications.

9.1.1 Direct connected hollow shaft electric motors are used in a vertical position.

9.1.2 A right angle gear drive is required to connect internal combustion engines to vertical pumps.

9.1.3 Multiple V-belt heads and flat pulley heads are suited to small pump installations.

10. AUTOMATIC OPERATION

10.1 Automatic operation is used primarily with electrical power sources. Points to be considered in applying such equipment are given below:

a) Evaluation of added installation and maintenance costs against advantages sought.
b) Possible lack of interest on the part of owner or operator if operation is too much automated.
c) Controls compatible with state electricity rules.
d) Possibility of moisture getting into or submergence of controls.
e) Hazards of winter operation in cold climates.
f) Greater requirement of operator vigilance and maintenance including lubrication and trash rack cleaning.

10.2 Automatic controls are available for internal combustion engines such as an electric starting system for air cooled engines. Such systems are not readily adaptable to most pump installations.

10.3 Protective controls shall be supplied for all installations.

10.3.1 Automatic or electric units should have safety shut-off against overload, low voltage, and excessive heating.

10.3.2 Internal combustion engines should have controls which protect against overheating, low oil pressure and excessive speed.

10.3.3 Auxiliary warning devices, such as signal lights and siren on the pump house should be provided for attention of the owner or operator.

11. HOUSING

11.1 Type of housing for pumping plants depends upon importance and size of the plant, type of power used and plant location.

11.1.1 Factors influencing need for housing are air temperature, wind, humidity, precipitation and flooding fuel storage, safety, vendalism and plant appearance.

11.1.2 Materials used for housing should be fire resistant, waterproof, durable and easily maintained.

11.1.3 Size of housing should be sufficient for the containment and servicing of the equipment. Provision should be made for removing the pumps when required.

12. TRASH RACKS

12.1 Trash racks should be provided to prevent entry of floating debrish/ trash into sumps where damage to pumps might otherwiseoc cur.

12.1.1 Trash racks should be set not less than 2½ times the suction bell diameter in front of the centerline of the pumps.

12.1.2 Velocity of flow through the trash rack should not exceed 0·6 m/s.

12.1.3 Recommended trash rack bar spacing is as follows:

Pump Diameter, mm	*Bar Spacing*, mm
Up to 400	20
450-600	25 to 38
760-1 060	50
1 060 and above	65 to 75

12.1.4 Trash racks should be sloped so that cleaning by hand is easily done or they should be equipped with mechanical cleaner.

12.1.5 Where trash racks are not feasible, galvanized basket strainers may be used on small pumps to prevent entry of small gravel and debris.

INDIAN STANDARDS

ON

FARM DRAINAGE

IS:

8967 (Part 1)-1978	Farm drainage clay tiles: Part 1 Tiles with open joints
8967 (Part 2)-1983	Part 2 Perforated tiles with collar joints
8968-1973	Farm drainage concrete tiles
9271-1979	Farm drainage plastic pipes
9633-1980	Farm drainage asbestos cement pipes
9696-1980	Code of practice for installation for farm drainage tile or pipe system
9979-1981	Code for design and laying of mineral filter for tile drain system
10907-1984	Code for design of farm drainage tile or pipe drain system